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Magnetic Nanoparticles for Biomedical Applications

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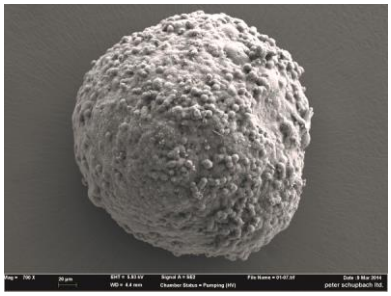
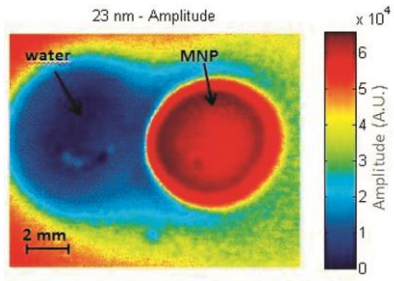
Magnetic nanoparticles will play a major role in biomedical applications because of their unique nature to emit heat while they are stimulated by an alternating magnetic field. Indeed, some of them are already used as contrast agents in magnetic resonance imaging or for hyperthermia treatments. The aim of this work is to investigate the uptake of magnetic nanoparticles in microtissues with the help of an innovative thermography based method. Truly how the particles will distribute onto the tissue is of a particular importance to assess treatment potential. This thesis used human HCT-116 colon cancer cells to cultivate the needed spherical microtissues. To these three dimensional tissues, iron oxide nanoparticles of different sizes and concentrations were added. The modified tissues were analyzed under a state-of-the-art infrared microscope using lock-in thermography. For the heating device, a water cooled coil which generates the required alternating magnetic field was used. The purpose of measuring the heat emission of nanoparticles at different sizes and concentrations was to determine a dependency of the resulting intensity to these characteristics. Furthermore, an examination of the influence of the nanoparticles on the viability of the microtissues was implemented. To detect the exact location of the nanoparticles on or in the microtissues, scanning electron microscopy and transmission electron microscopy was used. Results show that magnetic nanoparticles can be detected with lock-in thermography. The measured heat intensity of drops containing nanoparticles dissolved in double-distilled water were clearly distinguishable from drops consisting only of distilled water. The findings suggest that the size of the particles is the most important factor which plays a role in generating heat. To examine the exact distribution of the nanoparticles in microtissues, the used setup needs to pass further adaptations to reduce the image artifacts that are caused by backscatter.



SEM image of a microtissue produced at the ICBC in Wädenswil. These tissues have been made by applying the hanging-drop method and consist of human colon cancer cells.



Thermographic amplitude image. The image shows two drops consisting of distilled water, where one is treated with magnetic nanoparticles (Fe3O4). The particles lead to distinct heat emissions.